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# QUALITY OF ICEBERG LETTUCE IN FILM OVERWRAPS DURING SIMULATED EXPORT

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# ERRATUM

ARS W-33, "Quality of Iceberg Lettuce in Film Overwraps During Simulated Transport"

Page 3, paragraph 3, line 5. Insert before reference (5): "Categories within this scale are similar to those of Kader et al."

Page 3, table 1. Substitute the following table in place of the one that appears in the publication:

Table 1.--*Salability of lettuce wrapped in 3 types of film before and after retail trim, fall 1972*

| Examination after indicated holding period and temperature (°F) | Percentage of lettuce salable after holding in indicated type of film[1] | | |
|---|---|---|---|
| | Polypropylene | Polyethylene | Polystyrene |
| BEFORE RETAIL TRIM (BY HEAD COUNT) | | | |
| After 18 days at 38° | 97a | 97a | 98a |
| After 18 days at 38° plus 4 days at 50° | 38a | 71b | 51ab |
| AFTER RETAIL TRIM (BY WEIGHT) | | | |
| After 18 days at 38° | 99.8a | 99.7a | 99.8a |
| After 18 days at 38° plus 4 days at 50° | 84.8a | 93.8b | 89.0ab |

[1]Means on a line having no letter in common differ at the 5-percent level.

Page 4, paragraph 4, line 8. Delete "(none)" and "(rating 1)."

Page 5, table 2, footnote 1. Change 18° to 38°.

## ABSTRACT

Three types of film overwraps for lettuce (polypropylene, polyethylene, and polystyrene) were held under simulated conditions of transit to overseas markets. Quality differences were slight; however, more heads were salable when wrapped in polyethylene film than when wrapped in either polypropylene or polystyrene film and stored for 18 days at 38° Fahrenheit plus 4 days at 50°. The percentage of salable lettuce by weight was highest for polyethylene wraps. Statistically, however, only the differences between the polyethylene and polypropylene films were significant. Polystyrene film was not significantly different from either polyethylene or polypropylene film.



KEYWORDS: Decay, Export, Lettuce weight, Marketing, Polyethylene, Polypropylene, Polystyrene, Prepackaging film, Quality, Salability, Temperature, Transportation.


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# QUALITY OF ICEBERG LETTUCE IN FILM OVERWRAPS DURING SIMULATED EXPORT

By R. Tom Hinsch, Roger E. Rij, and Joseph K. Stewart[1]

## INTRODUCTION

In 1974, the total value of U.S. agricultural exports was more than $21 billion. Although fresh fruits and vegetables accounted for less than 5 percent of this amount (*1*)[2], the volume of these commodities going into export is increasing rapidly. Some of the largest potential markets for U.S. fresh fruits and vegetables are in Europe and the Far East, because these areas do not have a sufficient volume of fresh commodities on a year-round basis.

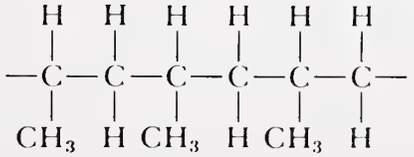
The Western United States produces a consistent and abundant supply of high-quality head lettuce, which has found a ready market overseas when delivered in good condition. However, many shipments of lettuce arrive at European markets in poor condition because of improper refrigeration during transit, poor or rough handling, improper packaging, lengthy transit, or delays in transit.

Film wraps serve to reduce spoilage and moisture loss (*4*, *7*) and are used for most of the western lettuce exported to Europe. Film-wrapped lettuce is used by approximately 14 percent of domestic receivers (*6*), but little research has been done to compare the types of film currently used for maintaining the quality of lettuce (*2*).

## METHODS AND MATERIALS

Two series of laboratory tests, evaluating three types of film wraps for lettuce, were conducted during the fall of 1972 and spring of 1973. Each test series was replicated four times. The films used were polypropylene, low-density polyethylene, and polystyrene.

Polypropylene film is similar to polyethylene, but the molecular structure is more complex because of the side groups of hydrocarbon spaced along the straight-chain hydrocarbon:



Antioxidants are added to prevent quick deterioration due to oxygen and light.

---

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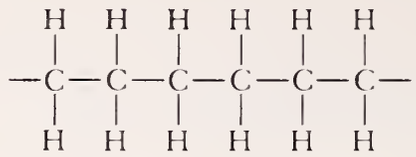
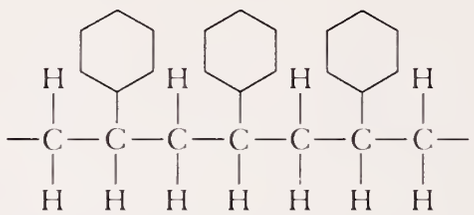
[2]Italic numbers in parentheses refer to Literature Cited, p. 6.

The density of polypropylene film was 0.90 g/cm$^3$. The polyethylene film is one of the simplest polymers in composition, being essentially a straight-chain hydrocarbon:



The film tested was a low-density type, 0.92 g/cm$^3$. The polystyrene film is produced from a reaction of ethylene with benzene to form ethylbenzene, which is dehydrogenated to make a styrene monomer. Polymerization takes place in the presence of organic peroxides and heat to yield polystyrene:



The density of the polystyrene was 1.05 g/cm$^3$ (*3*). All the films were 1.5 mils thick.

Lettuce wrapped in polypropylene or polystyrene is usually passed through a heat-shrink tunnel, but that wrapped in polyethylene is not. The first series of tests was made with commercially wrapped lettuce. The second series of tests was conducted to determine whether lettuce quality was affected by passing it through the heat tunnel, rather than by the type of film used. The cultivar 'Calmar' was used in all the tests except one, in which 'Montemart' was used. All lettuce was grown in the Salinas-Watsonville area of California.

In the first series of tests, the harvesting, trimming, and packaging of the lettuce was done under commercial conditions, in which the lettuce was wrapped by machine in the field. Films were heat-sealed at the butt end of the lettuce heads. The sealing temperature for the polypropylene and polystyrene films was 300° to 350° F and for the polyethylene film was approximately 225°. Twenty-four heads of film-wrapped lettuce were then packed in waxed, moisture-resistant, corrugated fiberboard, regular slotted container (RSC) boxes, and vacuum cooled in a commercial cooler to an average temperature of 35°. The nine test boxes were transported to the Market Quality and Transporation Research Laboratory in Fresno, Calif.

In the second series of laboratory tests, the lettuce was not film wrapped in the field but was packed naked into standard, corrugated fiberboard, RSC boxes. In the laboratory, each head of lettuce was wrapped with one of the three types of film, which was sealed at the butt end of the lettuce. The sealing temperature for all three types of film was 300° to 350° F. Seventy-two heads of lettuce were passed through a heat tunnel at approximately 350° to 370°, and an equal number of heads wrapped in each film type were not heat shrunk. After repacking, both the heat-treated and nonheat-treated lettuce were vacuum cooled to an average temperature of 37°.

In the laboratory, all test packages in both series of tests were held at 38° F for 18 days to simulate overland and overseas (surface truck and boat) shipments to European markets, after which one-half of each box of lettuce (12

heads) was examined. The other one-half of each box was examined after holding for an additional 4 days at 50° to simulate the wholesale-retail market.

The individual heads of lettuce were evaluated at each of the two examinations as follows: Each head was judged for salability before and after being trimmed, as though by a retailer. In addition, the overall general appearance of each head was rated using a scale in which 1 = inedible, 2 = poor, 3 = fair, 4 = good, and 5 = excellent (*5*).

Each test lot of lettuce was trimmed to simulate trimming by a retailer. The percentage of salable lettuce at the retail level was determined by the weight of the head before trim less the weight of the trimmed leaves.

Each head also was examined for decay, crushing and bruising, tipburn, russet spotting, rib discoloration, and brown stain. The rating scale used for these defects was 1 = none, 2 = trace, 3 = slight, 4 = moderate, and 5 = severe.

## RESULTS

### Salability

#### Salability Before Retail Trim

In the first series of tests, a significantly higher percentage of heads wrapped in polyethylene film was salable after 18 days storage at 38° F plus 4 days at 50° than heads wrapped in polypropylene film (table 1). No significant difference was detected between lettuce wrapped in polystyrene and polyethylene or in polystyrene and polypropylene. Salability did not differ in lettuce wrapped in either of the three films after 18 days at 38°. As would be expected, significantly more heads were salable at the first examination than at the second when wrapped in any of the three types of film.

Table 1.--*Salability of lettuce wrapped in 3 types of film before and after retail trim, fall 1972*

| Examination after indicated holding period and temperature (°F) | Percentage of heads salable after holding in indicated type of film[1] | | |
|---|---|---|---|
| | Polypropylene | Polyethylene | Polystyrene |
| | BEFORE RETAIL TRIM | | |
| After 18 days at 38° | 97a | 97a | 98a |
| After 18 days at 38° plus 4 days at 50° | 38a | 71b | 51ab |
| | AFTER RETAIL TRIM | | |
| After 18 days at 38° | 99.8a | 99.7a | 99.8a |
| After 18 days at 38° plus 4 days at 50° | 84.8a | 93.8b | 89.0ab |

[1]Means on a line having no letter in common differ at the 5-percent level.

### Salability After Retail Trim

Retail trimming of the lettuce heads after storage eliminated the difference in salability related to the type of film wrap. All the film-wrapped lots of lettuce were 100-percent salable at the first examination. No significant difference among film types was detected at the second examination. However, significantly more lettuce was salable at the first than at the second examination in all three types of film.

### Salable Lettuce by Weight After Trim

No differences were detected in the percentage of salable lettuce based on weight among the types of film wraps after the first examination (18 days at 38° F)(table 1). A significant difference among film types was detected after the second examination (18 days at 38° plus 4 days at 50°), but only between polyethylene film and polypropylene film. No difference occurred between polystyrene and polyethylene or polystyrene and polypropylene. As in previous results, the percentage of salable lettuce by weight differed significantly between the first and second examination.

## General Appearance

No differences in appearance were detected in the percentage of heads rated "good to excellent" (4.0 or better rating) among the different film types after the first examination (after 18 days at 38° F) or after the second examination (after 18 days at 38° plus 4 days at 50°)(table 2). A significant difference was detected between the first and second examination. No differences were detected in the percentage of heads rated fair to poor (2 to 3 rating) or rated inedible (1 rating) among the different types of film after the first or second examination. A difference between the first and second examination was detected in the appearance of the lettuce.

## Decay

Significantly less decay (none, 1 rating) developed in lettuce wrapped in polyethylene film (87 percent) than in polypropylene film (81 percent) at the first examination (table 2). There was no significant difference between lettuce wrapped in polystyrene (84 percent) and polyethylene (87 percent), or polystyrene (84 percent) and polypropylene (81 percent). At the second examination, no significant differences were detected among lots of lettuce wrapped in the three film types. As would be expected, the amount of decay differed significantly after examination 1 (none) and examination 2 (rating 1). No differences were detected betwen films in the trace-to-slight or moderate-to-severe decay categories.

## Other Quality Factors

The incidence of tipburn, russet spotting, rib discoloration, brown stain, crushing, and bruising was negligible. Passing wrapped lettuce through a heat tunnel had no significant effect on quality.

Table 2.--*Appearance and decay of lettuce wrapped in 3 types of film, fall 1972*

| Rating | Specified holding period and temperature[1] | Percentage of heads with indicated appearance or decay rating after holding in film wraps[2] | | |
|---|---|---|---|---|
| | | Polypropylene | Polyethylene | Polystyrene |
| | | APPEARANCE OF LETTUCE | | |
| Good to Excellent | 1 | 76a | 79a | 86a |
| | 2 | 5b | 17b | 12b |
| Fair to Poor | 1 | 24a | 20a | 14a |
| | 2 | 64b | 76b | 63b |
| Inedible | 1 | 0a | 0a | 0a |
| | 2 | 31b | 7b | 25b |
| | | DECAY OF LETTUCE | | |
| Moderate to Severe | 1 | 0a | 1a | 1a |
| | 2 | 33b | 13b | 13b |
| Trace to Slight | 1 | 19a | 13a | 16a |
| | 2 | 67b | 50b | 70b |
| None | 1 | 81a | 87b | 84ab |
| | 2 | 10b | 37b | 17b |

[1]1, examined after 18 days at 38° F. 2, examined after 18 days at 18° plus 4 days at 50°.

[2]Means on a line having no letter in common differ at the 5-percent level.

## DISCUSSION

When lettuce was wrapped in polyethylene film, more heads were salable after 18 days storage at 38° F plus 4 days at 50° than were salable when the lettuce was wrapped in either polypropylene or polystyrene film. Also, the percentage of salable lettuce by weight was higher in the polyethylene wraps. Statistically, however, only the difference between the polyethylene and polypropylene film was significant. Polystyrene film was not statistically different from either polyethylene or polypropylene film. The various films had no significant effect on the percentage of salable heads after retail trim. General appearance of the lettuce was about equal in the three types of film wraps. As would be expected, the quality ratings of the lettuce decreased between the first and second examination, and the decrease was not influenced by type of film.

In general, quality differences were slight among lots of lettuce wrapped in the three types of film (polyethylene, polypropylene, and polystyrene). Consequently, a choice of the particular type of film for lettuce may be based on cost factors and availability of the film from manufacturers. New types of film are continually being developed, and research will be necessary to determine their effects on the keeping quality of lettuce.

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